



US009152012B2

(12) **United States Patent**
Yamaguchi

(10) **Patent No.:** **US 9,152,012 B2**
(45) **Date of Patent:** **Oct. 6, 2015**

(54) **POWER SOURCE SWITCHING DEVICE AND ELECTRONIC APPLIANCE**

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,784,626	A *	7/1998	Odaohara	713/300
8,941,264	B2 *	1/2015	Scruggs et al.	307/52
2004/0155627	A1 *	8/2004	Stanesti et al.	320/127
2012/0272691	A1 *	11/2012	Leibman et al.	68/17 R

FOREIGN PATENT DOCUMENTS

JP	2-311131	12/1990
JP	8-336243	12/1996
JP	2007-089350	4/2007
JP	2008-125199	5/2008

* cited by examiner

Primary Examiner — W B Perkey

(74) *Attorney, Agent, or Firm* — Panasonic Patent Center

(71) Applicant: **Panasonic Corporation**, Osaka (JP)

(72) Inventor: **Shun Yamaguchi**, Hyogo (JP)

(73) Assignee: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 407 days.

(21) Appl. No.: **13/863,641**

(22) Filed: **Apr. 16, 2013**

(65) **Prior Publication Data**

US 2013/0272691 A1 Oct. 17, 2013

(30) **Foreign Application Priority Data**

Apr. 17, 2012 (JP) 2012-093622

(51) **Int. Cl.**
G03B 7/26 (2006.01)
G05F 3/08 (2006.01)
H02J 1/10 (2006.01)

(52) **U.S. Cl.**
CPC .. **G03B 7/26** (2013.01); **G05F 3/08** (2013.01);
H02J 1/108 (2013.01); **G03B 2217/007**
(2013.01)

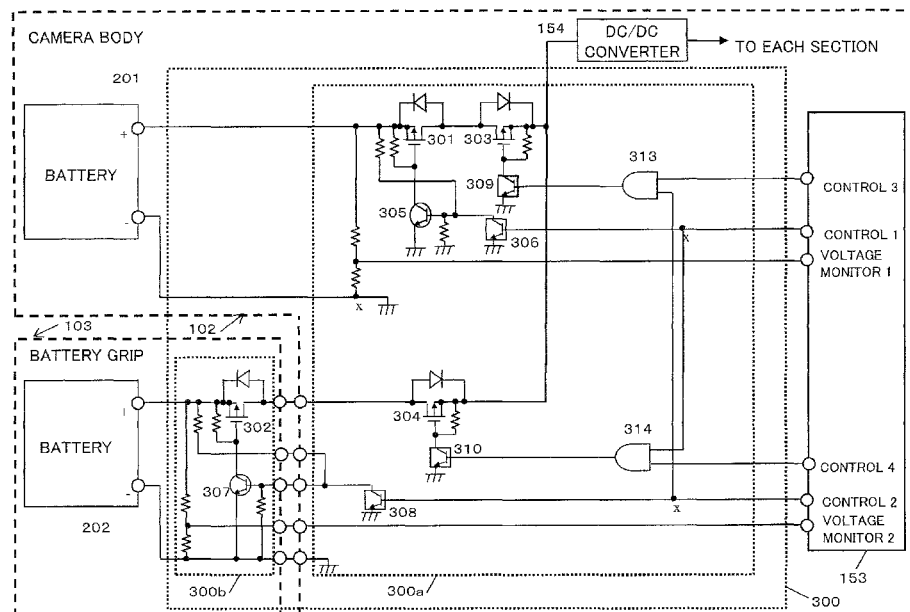
(58) **Field of Classification Search**
CPC G03B 7/26; G05F 3/08; H02J 9/04;
H02J 9/06

See application file for complete search history.

ABSTRACT

A power source switching device includes a first switch circuit provided between a first power source and a load section, a second switch circuit provided between a second power source and the load section, a third switch circuit provided between the first power source and the load section in series with the first switch circuit, a fourth switch circuit provided between the second power source and the load section in series with the second switch circuit, a logic circuit that controls the third and the fourth switch circuits to prevent at least one of the third and fourth switch circuits from turning on while both of the first and second switch circuits are in an on state, and a control circuit that controls the first switch circuit, the second switch circuit, and the logic circuit.

11 Claims, 6 Drawing Sheets



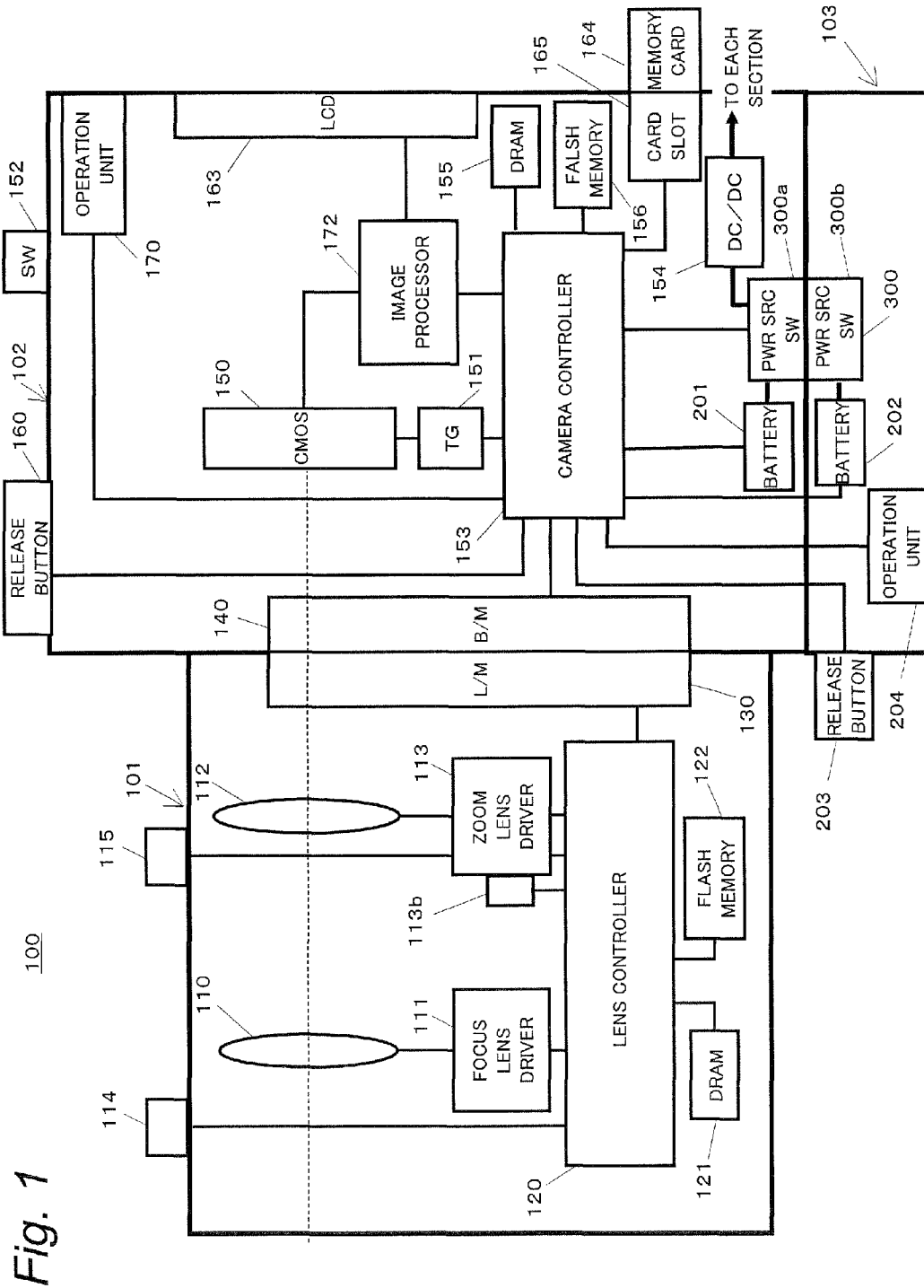


Fig. 2

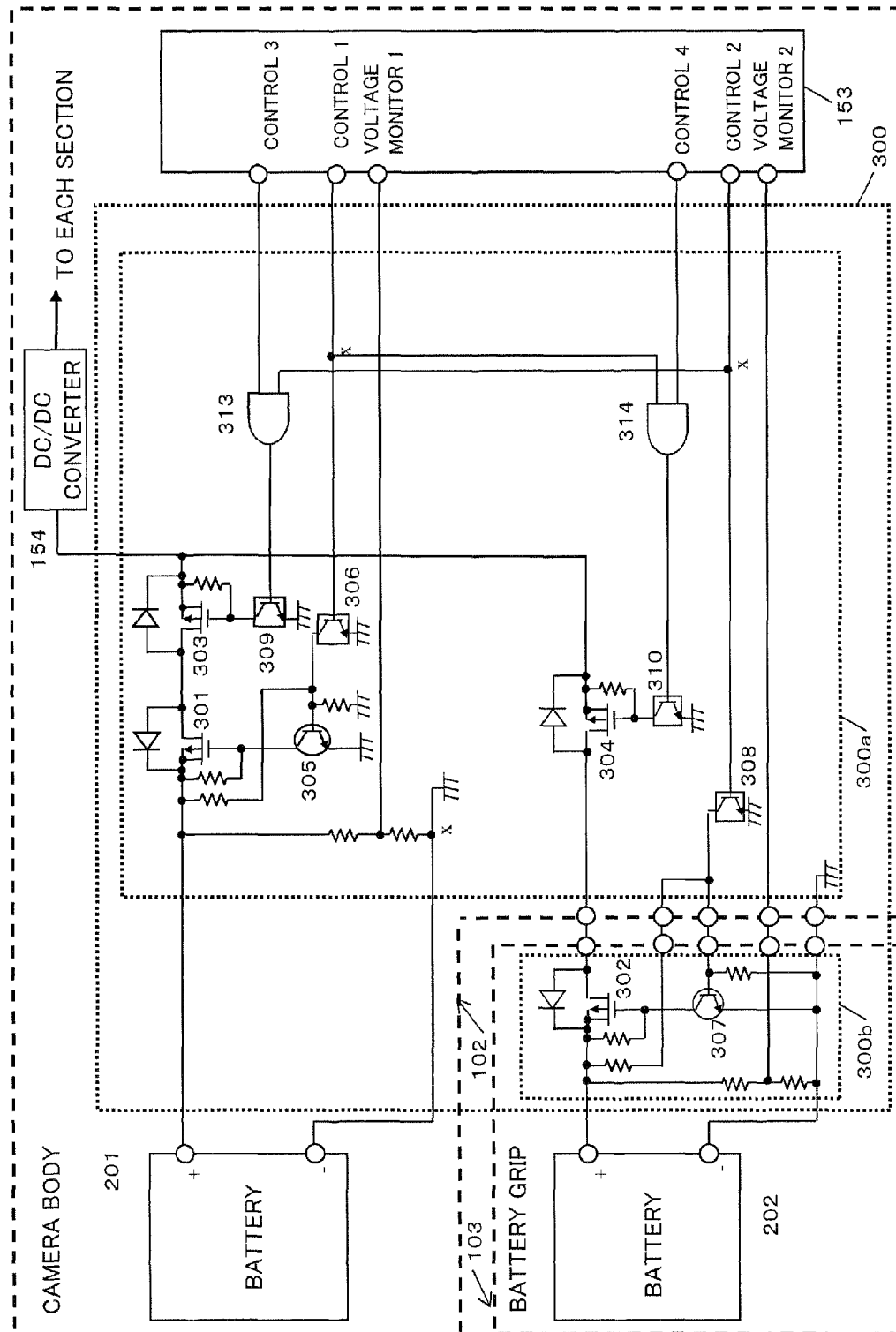


Fig. 3

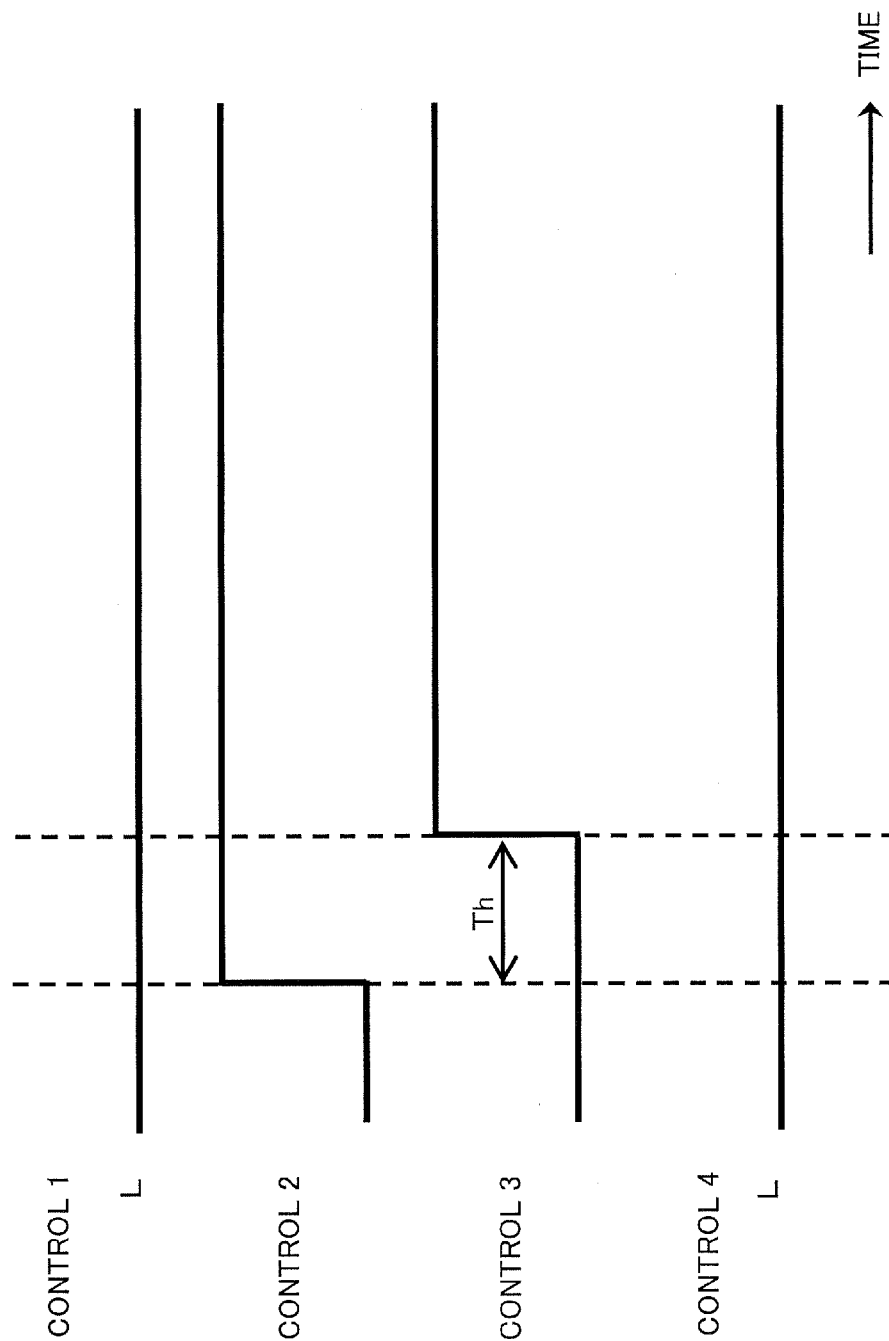
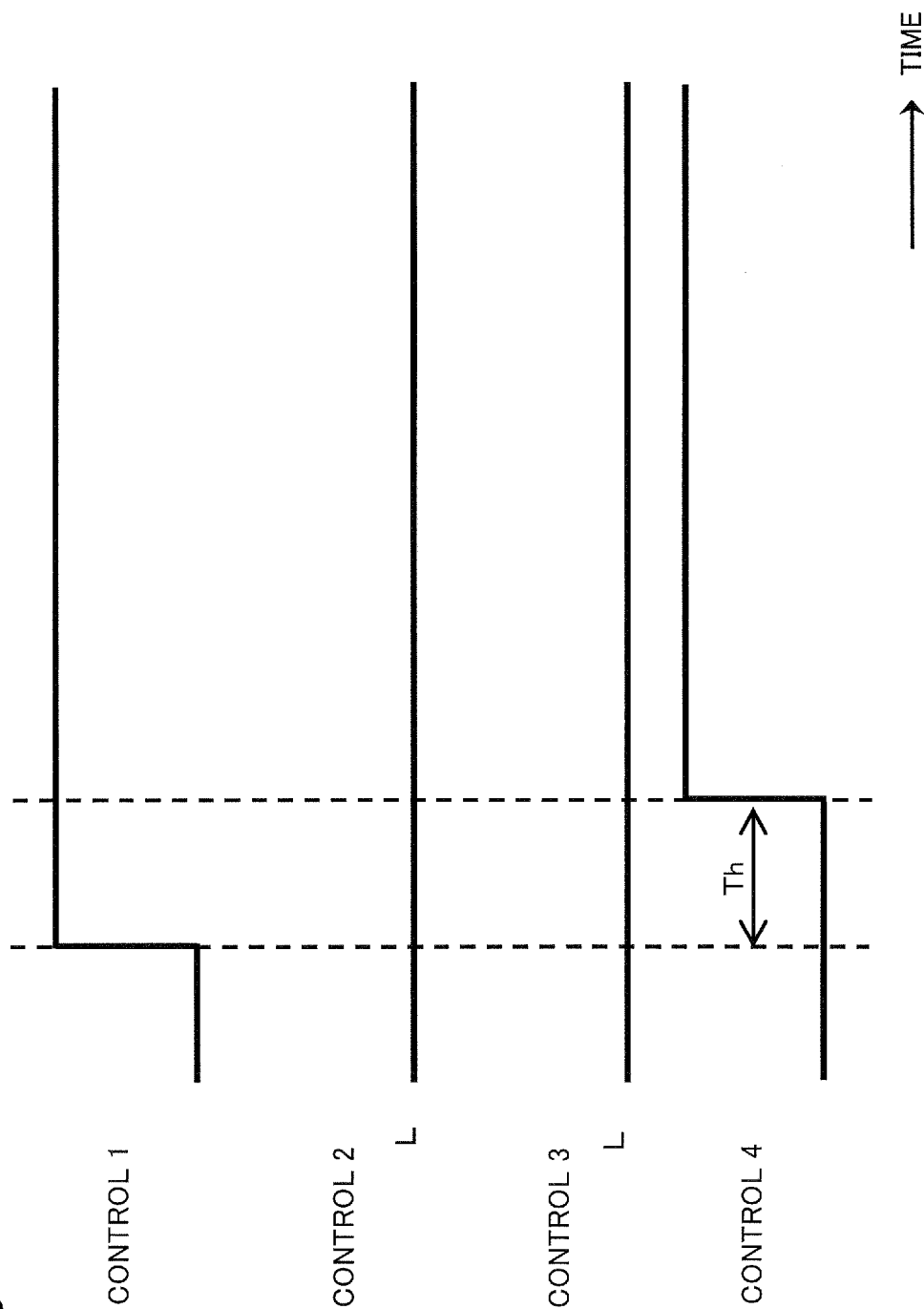


Fig. 4



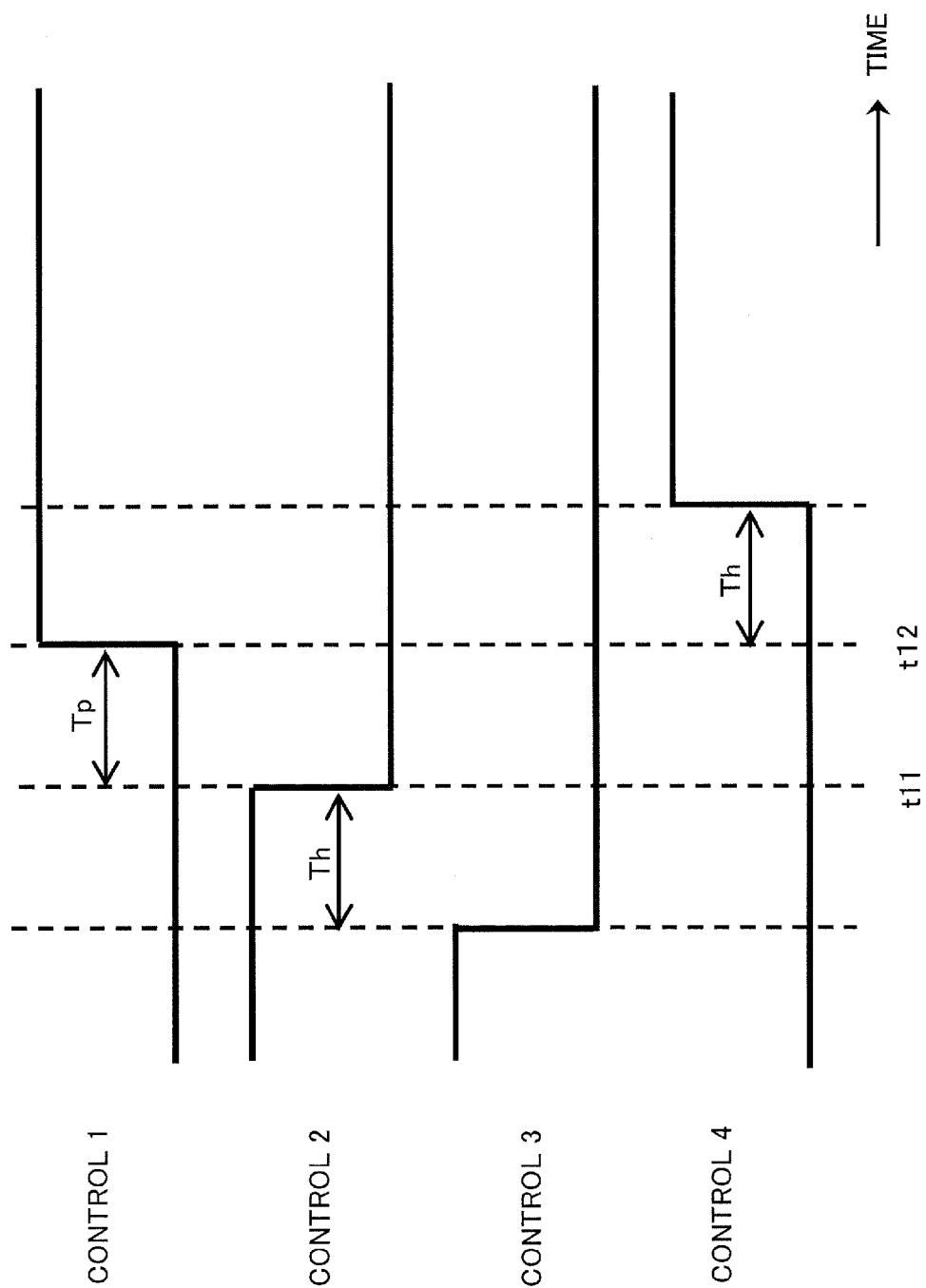
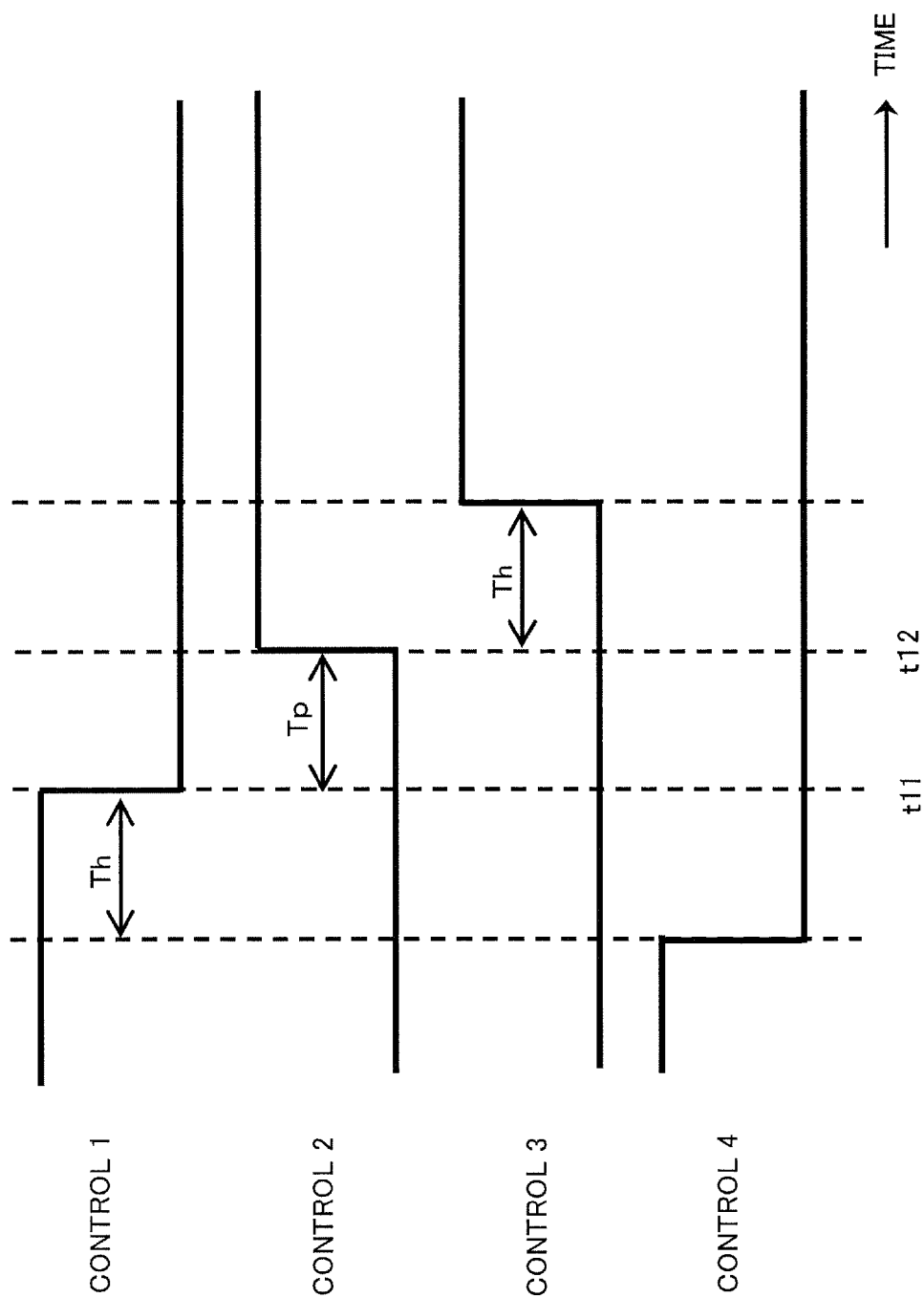


Fig. 5

Fig. 6



1

POWER SOURCE SWITCHING DEVICE AND ELECTRONIC APPLIANCE

BACKGROUND

1. Technical Field

The present disclosure relates to a power source switching device which performs switching control to switch among a plurality of batteries for use, and an electronic appliance provided with the power source switching device.

2. Related Art

Some conventional electronic appliances such as digital cameras have a plurality of batteries so that they can switch the batteries to use any one of the batteries.

For example, JP 2007-89350 A discloses a configuration having a main power source and a sub-power source. According to the configuration, when detecting malfunction of power supply state of the main power source, the power supply from the main power source is maintained for a predetermined time period and then the power supply from the main power source is cut off while starting power supply from the sub-power source.

A conventional electronic appliance having such a configuration might be in a malfunction state of having the plurality of batteries connected directly (shorted) in the case where a control unit (controller, microcomputer) for performing switching control of the power supply cannot perform a normal operation (in the case of runaway of a control unit) for some reason. As a result of such a case, a charging operation is performed by one of the batteries to the other of the batteries, which causes an adverse effect on the batteries and the electronic appliance body.

SUMMARY

An object of the present disclosure is to provide a power source switching device which keeps normal power supply even in the case where a control unit for performing switching control on the power supply is in a malfunction state.

A power source switching device according to the present disclosure is a device which switches between a first power source and a second power source for a power source for supplying a driving voltage to a load section. The power source switching device includes:

a first switch circuit that is provided between the first power source and the load section;

a second switch circuit that is provided between the second power source and the load section;

a third switch circuit that is provided between the first power source and the load section in series with the first switch circuit;

a fourth switch circuit that is provided between the second power source and the load section in series with the second switch circuit;

a first diode that is provided in parallel with the third switch circuit for allowing a current to flow from the first power source to the load section and while preventing a current from flowing from the second power source into the first power source;

a second diode that is provided in parallel with the fourth switch circuit for allowing a current to flow from the second power source to the load section while preventing a current from flowing from the first power source into the second power source;

a logic circuit that controls the third switch circuit and the fourth switch circuit to prevent at least one of the third switch

2

circuit and the fourth switch circuit from turning on while both of the first switch circuit and the second switch circuit are in an on state; and

a control circuit that controls the first switch circuit, the second switch circuit, and the logic circuit.

According to the present disclosure, even in the case where a control unit for performing switching control on the power supply is in an extraordinary state and sends a control signal which would not be used under constraints of design, the power source switching device can prevent the batteries from being connected (short-circuited) with each other by means of hardware. Thus it can provide a power source switching device which keeps normal power supply.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a block diagram of a digital camera of a first embodiment;

FIG. 2 is a block diagram of a power source switching circuit of the digital camera;

FIG. 3 is a timing chart of control signals output from a camera controller (in the case where power is supplied from a battery in a camera body);

FIG. 4 is a timing chart of control signals output from the camera controller (in the case where power is supplied from a battery in a battery grip);

FIG. 5 is a timing chart of control signals output from the camera controller (in the case of switching the battery in the camera body to the battery in the battery grip); and

FIG. 6 is a timing chart of control signals output from the camera controller (in the case of switching the battery in the battery grip to the battery in the camera body).

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments will be described below in detail with reference to the drawings as required. However, unnecessarily detailed description may be omitted. For example, detailed description of already known matters and redundant description of substantially the same configuration may be omitted. All of such omissions are for facilitating understanding by those skilled in the art by preventing the following description from becoming unnecessarily redundant. The inventor(s) provide the attached drawings and the following description for those skilled in the art to fully understand the present disclosure and does not intend to limit the subject described in the claims by the attached drawings and the following description.

Embodiments will be described below in detail with reference to the drawings.

First Embodiment

A digital camera of a first embodiment will be described below with reference to the drawings.

1. Configuration

The configuration of the digital camera will be described below with reference to the drawing.

FIG. 1 is a block diagram illustrating a configuration of the digital camera according to the first embodiment. The digital camera 100 includes a camera body 102, an interchangeable lens 101 which can be mounted to the camera body 102, and a battery grip 103 which can be mounted to the camera body 102. The interchangeable lens 101 has a zoom lens 112 which is driven by a zoom lens driver 113. The camera body 102 can electrically drive the zoom lens 112 via a lens controller 120.

That is, the interchangeable lens **101** is an electromotive zoom lens. The camera body **102** has a power source switching circuit **300a**. The battery grip **103** can be mounted with a battery **202** and has a power source switching circuit **300b**. The power source switching circuit **300a** and the power source switching circuit **300b** composes a power source switching circuit **300**. The camera body **102** can control the power source switching circuit **300** by a camera controller **153**. That is, the camera body **102** can select whether to use a battery **201** or a battery **202**.

1-1. Configuration of Camera Body

The camera body **102** has a CMOS image sensor **150**, a liquid crystal display monitor **163**, an image processor **172**, a timing generator (TG) **151**, a camera controller **153**, a body mount **140**, a release button **160**, an operation unit **170**, a battery **201**, a power source switching circuit **300a**, a DRAM **155**, a flash memory **156**, and a card slot **165**.

The camera controller **153** controls the operation of the entire digital camera **100** by controlling each of components such as the CMOS image sensor **150**, according to an instruction input from an operating member such as the release button **160** and the operation unit **170**. The camera controller **153** sends a vertical synchronizing signal to the timing generator **151**. In parallel to that process, the camera controller **153** generates an exposure synchronizing signal based on the vertical synchronizing signal. The camera controller **153** periodically and repeatedly sends the generated exposure synchronizing signal to the lens controller **120** via the body mount **140** and a lens mount **130**. With the above described operation, the camera controller **153** can control the lenses such as a focus lens **110** in the interchangeable lens **101** in synchronous with the exposure. The camera controller **153** uses the DRAM **155** as a work memory in performing a control operation or an image processing operation. The camera controller **153** may be implemented by a hardwired electronic circuit or a microcomputer using a program. Alternatively, the camera controller **153** may be integrated into or separately provided from a semiconductor chip in which the image processor **172** and the DRAM **155** are formed.

The CMOS image sensor **150** is configured to include a light-receiving element, an AGC (gain control amplifier), and an AD converter. The light-receiving element converts optical signals collected by the interchangeable lens **101** into electric signals to generate image information. The AGC amplifies the electric signal output from the light-receiving element. The AD converter converts the electric signal output from the AGC into a digital signal. The CMOS image sensor **150** operates at a timing controlled by the timing generator **151**. The operation of the CMOS image sensor **150** under the control of the timing generator **151** includes a capture operation of a still image, a capture operation of a through image, a data transfer operation, and an electronic shutter operation. A through image, which is primarily a moving image, is displayed on the liquid crystal display monitor **163** for a user to compose the still image to capture. The image information generated by the CMOS image sensor **150** is supplied to the image processor **172**. Another image capturing device such as an NMOS image sensor or a CCD image sensor may be used in place of the CMOS image sensor **150**.

The image processor **172** performs predetermined image processing on the image data which has been converted into the digital signal by the AD converter in the CMOS image sensor **150**. For example, the predetermined image processing may include, but is not limited to, gamma correction process, white balance correction process, flaw correction process, YC conversion process, digital zoom process, compression process, and expansion process.

The liquid crystal display monitor **163** is a display unit installed on the rear of the camera body **102**. The liquid crystal display monitor **163** displays an image indicated by the image information for display processed by the image processor **172**. The liquid crystal display monitor **163** can selectively display the moving image and the still image. Besides, the liquid crystal display monitor **163** can display information including setting conditions and the like of the digital camera **100**. Although the liquid crystal display monitor **163** is described as an example of the display unit in the present embodiment, the display unit is not limited to that. For example, an organic electroluminescence EL display may be used as the display unit.

The flash memory **156** functions as an internal memory for storing image information and the like. The flash memory **156** stores programs and parameters to be used by the camera controller **153** in performing the respective controls.

The card slot **165** is connection means for mounting the memory card **164** to the camera body **102**. The card slot **165** can electrically and mechanically connect the memory card **164**. The card slot **165** may have a function of controlling the memory card **164**.

The memory card **164** is an external memory containing a storage element such as a flash memory. The memory card **164** can store data including image information processed by the camera controller **153**. The memory card **164** can also output data including image information stored therein. The image data read out from the memory card **164** is processed by the camera controller **153** or the image processor **172** and displayed, for example, on the liquid crystal display monitor **163**. Although the memory card **164** is described as an example of the external memory in the present embodiment, the external memory is not limited to that. For example, a recording medium such as an optical disk may be used as the external memory.

The body mount **140** can mechanically and electrically connect with the lens mount **130** (described later) of the interchangeable lens **101**. The body mount **140** together with the lens mount **130** can achieve communication of data between the camera body **102** and the interchangeable lens **101**. The body mount **140** sends the exposure synchronizing signal and other control signals which are received from the camera controller **153** to the lens controller **120** via the lens mount **130**. The body mount **140** also sends the signals, which are received from the lens controller **120** via the lens mount **130**, to the camera controller **153**.

The battery **201** supplies power for driving the digital camera **100**. The power supply **201** may be a dry battery or a rechargeable battery, for example. Instead of the battery **201**, the power supply may be configured to supply power to the digital camera **100** input from outside through a power cord. The power of the digital camera **100** is turned on/off by the power switch **152**. When the power of the digital camera **100** is turned on, the camera controller **153** supplies power to the respective components in the camera body **102**. The camera controller **153** also supplies power to the interchangeable lens **101** through the body mount **140** and the lens mount **130**. In the interchangeable lens **101**, the lens controller **120** supplies power to the respective components of the interchangeable lens **101**.

The power source switching circuit **300a** composes a part of the power source switching circuit **300**. The power source switching circuit **300** switches whether to supply power to the digital camera **100** from the battery **201** in the camera body **102** or from the battery **202** in the battery grip **103** (to be described later). The power source switching circuit **300** out-

5

puts power from the selected battery to a DC-DC converter **154**. The power source switching circuit **300** is controlled by the camera controller **153**.

The DC-DC converter **154** supplies power from the power source switching circuit **300** to the respective components (load sections) of the digital camera **100**. The DC-DC converter **154** converts the voltage supplied from the battery into a voltage appropriate for the respective components when supplying power to the respective components.

The release button **160** receives an operation to instruct the digital camera **100** to perform image capturing or autofocus by the user. The release button **160** can be operated in two stages including a half-press stage and a full-press stage. In response to the user's half-press operation on the release button **160**, the camera controller **153** performs the autofocus operation. In response to the user's full-press operation on the release button **160**, the camera controller **153** starts to record the image data generated at the moment of the full-press operation into the memory card **164**.

The operation unit **170** includes directional buttons which allow the user to direct up/down/right/left directional operations. When the interchangeable lens **101** having an electromotive zoom function is mounted to the camera body **102**, the camera controller **153** assigns the functions of zoom operation buttons to the right and left buttons of the operation unit **170**, respectively. For example, the camera controller **153** assigns the function of zoom operation changing toward the wide-angle end to the left button, and assigns the function of zoom operation changing toward the telephoto end to the right button. When the interchangeable lens **101** having the electromotive zoom function mounted to the camera body **102** has a zoom lever for the user to perform zoom operation, the camera controller **153** does not need to assign the functions of zoom operations to the operation unit **170**.

1-2. Configuration of Interchangeable Lens

The interchangeable lens **101** has a focus lens **110**, a focus lens driver **111**, a focus ring **114**, a zoom lens **112**, a zoom lens driver **113**, a zoom ring **115**, a lens controller **120**, a DRAM **121**, a flash memory **122**, and a lens mount **130**. The interchangeable lens **101** may further include a camera shake correction lens in addition to the lenses illustrated in FIG. 1.

The lens controller **120** controls the operation of the entire interchangeable lens **101**. The lens controller **120** may be implemented by a hardwired electronic circuit or a micro-computer using a program.

The DRAM **121** functions as a work memory used in control by the lens controller **120**. The flash memory **122** stores programs, parameters, and lens data used in the control by the lens controller **120**. Here, the lens data includes characteristic values specific to the interchangeable lens **101** such as, for example, name of the lens, lens ID, serial number, F number, and focal distance. The lens controller **120** sends the camera controller **153** the lens data, so that the camera controller **153** can perform the respective control operations according to the lens data, as described later.

The zoom lens **112** is a lens for changing the magnification of a subject image which is formed through an optical system of the interchangeable lens **101**. The zoom lens **112** may be composed of any number of lenses or any number of lens groups.

The zoom lens driver **113** is a mechanical system for driving the zoom lens **112** along the optical axis of the optical system according to the operation made by the user on the zoom ring **115**. The position of the zoom lens **112** is always detected by a zoom lens position detector **113b** and sent to the lens controller **120**.

6

The focus lens **110** is a lens for changing the focus state of a subject image incident through the optical system and is formed on the CMOS image sensor **150**. The focus lens **110** may be composed of any number of lenses or any number of lens groups.

The focus ring **114** is installed on the outside surface of the interchangeable lens **101**. When the focus ring **114** is operated by the user, information on amount of operation on the focus ring **114** is notified to the lens controller **120**. Based on the notified information on amount of operation on the focus ring **114**, the lens controller **120** causes the focus lens driver **111** to drive the focus lens **110**. For that purpose, the lens controller **120** recognizes the position of the focus lens **110**.

The focus lens driver **111** drives the focus lens **110** to move forward and backward along the optical axis of the optical system under the control of the lens controller **120**. The focus lens driver **111** may be implemented by, for example, a stepping motor, a DC motor, an ultrasonic motor or the like.

1-3. Configuration of the Battery Grip

The battery grip **103** has the battery **202**, the power source switching circuit **300b**, the release button **203**, and the operation unit **204**.

The battery **202** supplies power for driving the digital camera **100**. The battery **202** may be a dry battery or a rechargeable battery, for example. Instead of the battery **202**, the power supply may be adapted to energize the digital camera **100** from outside through a power cord. The digital camera **100** is turned on/off with the power switch **152**. When the digital camera **100** is turned on, the camera controller **153** supplies power to the respective components of the camera body **102**. The camera controller **153** also supplies power to the interchangeable lens **101** through the body mount **140** and the lens mount **130**. In the interchangeable lens **101**, the lens controller **120** supplies power to the respective components of the interchangeable lens **101**.

The power source switching circuit **300b** forms apart of the power source switching circuit **300**. The power source switching circuit **300** switches whether to supply power to the digital camera **100** from the battery **201** in the camera body **102** or the battery **202** in the battery grip **103** (to be described later). The power source switching circuit **300b** is controlled by the camera controller **153**.

The release button **203** receives an operation by the user for an instruction for image capturing or autofocus. The release button **203** can be operated in a two-stage operation including a half-press operation and a full-press operation. In response to the user's half-press operation on the release button **203**, the camera controller **153** performs the autofocus operation. In response to the user's full-press operation on the release button **203**, the camera controller **153** records the image data generated at the moment of the full-press operation into the memory card **164**.

The operation unit **204** includes directional buttons which allow the user to direct up/down/right/left directional operations. When the interchangeable lens **101** with an electric zoom function is mounted to the camera body **102**, the camera controller **153** assigns the functions of zoom operations to the right and left buttons of the operation unit **204** respectively. For example, the camera controller **153** assigns the function of a zoom operation for changing the zoom toward the wide-angle end to the left button, and assigns the function of a zoom operation for changing the zoom toward the telephoto end to the right button. When the interchangeable lens **101** with the electric zoom function mounted to the camera body **102** has a zoom lever for the user to perform zoom operation, the camera controller **153** does not need to assign the functions of zoom operation to the operation unit **204**.

The battery **201** is an example of a first power source. The battery **202** is an example of a second power source. The power source switching circuit **300** is an example of the power source switching device. The digital camera **100** is an example of the electronic appliance.

1-4. Configuration of Power Source Switching Circuit

A detailed configuration of the power source switching circuit **300** will be described with reference to FIG. **2**. The power source switching circuit **300** includes the power source switching circuit **300a** provided in the camera body **102** and the power source switching circuit **300b** provided in the battery grip **103**.

The power source switching circuit **300** includes a P channel MOSFET **301** for connecting and disconnecting the battery **201** and a P channel MOSFET **302** for connecting and disconnecting the battery **202**. The power source switching circuit **300** further includes a P channel MOSFET **303** for disconnecting a current flowing from the battery **202** into the battery **201** and a P channel MOSFET **304** for disconnecting a current flowing from the battery **201** into the battery **202**. The power source switching circuit **300** further includes an NPN transistor **305** and an NPN transistor **306** for driving the FET **301** and an NPN transistor **307** and an NPN transistor **308** for driving the FET **302**. The power source switching circuit **300** further includes an NPN transistor **309** for driving the FET **303** for disconnecting and an NPN transistor **310** for driving the FET **304** for disconnecting.

The source of the FET **301** is connected with the positive electrode of the battery **201**. The drain of the FET **301** is connected with the drain of the FET **303**. The gate of the FET **301** is connected with the collector of the transistor **305**.

The source of the FET **302** is connected with the positive electrode of the battery **202**. The drain of the FET **302** is connected with the drain of the FET **304**. The gate of the FET **302** is connected with the collector of the transistor **307**.

The source of the FET **303** is connected with the source of the transistor **304** and the DC-DC converter **154**. The gate of the FET **303** is connected with the collector of the transistor **309**. The gate of the FET **304** is connected with the collector of the transistor **310**.

The base of the transistor **305** is connected with the collector of the transistor **306**. The emitter of the transistor **305** is grounded.

The base of the transistor **306** is connected with a terminal of a control signal **1** of the camera controller **153**. The emitter of the transistor **306** is grounded.

The base of the transistor **307** is connected with the collector of the transistor **308**. The emitter of the transistor **307** is grounded.

The base of the transistor **308** is connected with a terminal of a control signal **2** of the camera controller **153**. The emitter of the transistor **308** is grounded.

The base of the transistor **309** is connected with the output of an AND circuit **313**. The emitter of the transistor **309** is grounded.

The base of the transistor **310** is connected with the output of an AND circuit **314**. The emitter of the transistor **310** is grounded.

Here, the FET **301**, the FET **302**, the FET **303**, and the FET **304** include parasitic diodes, respectively. In FIG. **2**, the parasitic diodes are illustrated for convenience. The parasitic diode allows a current to flow from the drain to the source of each FET.

Note that the part of the FET **301**, which is conceptually other than the parasitic diode and performs the switching operation, is an example of a first switch circuit. The part of the FET **302**, which is conceptually other than the parasitic

diode and performs the switching operation, is an example of a second switch circuit. The part of the FET **303** which is conceptually other than the parasitic diode and performs the switching operation is an example of a third switch circuit.

The part of the FET **304** which is conceptually other than the parasitic diode and performs the switching operation is an example of a fourth switch circuit. The parasitic diode of the FET **303** is an example of a first diode. The parasitic diode of the FET **304** is an example of a second diode.

The power source switching circuit **300** has the AND circuit **313** for generating a control signal for the FET **309** and the AND circuit **314** for generating a control signal for the FET **310**. The AND circuit **313** inputs the control signal **3** and the control signal **2** from the camera controller **153**, and has an output which is connected with the base of the transistor **309**. The AND circuit **314** inputs the control signal **4** and the control signal **1** from the camera controller **153**, and has an output which is connected with the base of the transistor **310**. The AND circuits **313** and **314** may be composed of a transistor or the like.

The control signal **1** is a signal for controlling ON (conduction)/OFF (out of conduction) of the FET **301**. When the control signal **1** is Low (Lo), it turns on the FET **301** to bring the FET **301** into conduction. When the control signal **1** is High (Hi), it turns off the FET **301** to bring the FET **301** out of conduction. The control signal **2** is a signal for controlling ON (conduction)/OFF (out of conduction) of the FET **302**. When the control signal **2** is Low, it turns on the FET **302** to bring the FET **302** into conduction. When the control signal **2** is High, it turns off the FET **302** to bring the FET **302** out of conduction.

TABLE 1

Control Signal	Logic	Operation
Control Signal 1	Low	to turn FET 301 On (conduction)
	High	to turn FET 301 off (out of conduction)
Control Signal 2	Low	to turn FET 302 on (conduction)
	High	to turn FET 302 off (out of conduction)

The control signal **3** is a signal for forcing the FET **303** for disconnection, to be turned off (out of conduction) (or in one-direction conducting state). Specifically, the control signal **3** of Low turns off the FET **303** for disconnection to be out of conduction. The control signal **4** is a signal for forcing the FET **304** for disconnection to be out of conduction (to be in a one-direction conducting state). Specifically, the control signal **4** of Low turns off the FET **304** for disconnection to be out of conduction.

The FET **301** is controlled to be ON (in conduction) when the control signal **1** output from the camera controller **153** of the camera body **102** is Lo, while when the control signal **1** is Hi, the FET **301** is controlled to be OFF (out of conduction) (see Table 1). Specifically, when the control signal **1** is Lo, the transistor **306** is turned off, so that Hi is input to the base of the transistor **305**. As a result, the transistor **305** is turned on so that Lo is input to the gate of the FET **301**. Consequently, the FET **301** is turned on to be in conduction. On the other hand, when the control signal **1** is Hi, the transistor **306** is turned on, so that Lo is input to the base of the transistor **305**. As a result, the transistor **305** is turned on, so that Hi is input to the gate of the FET **301**. Consequently, the FET **301** is turned off to be out of conduction.

The FET **302** is controlled to be ON (in conduction) when the control signal **2** output from the camera controller **153** of the camera body **102** is Lo, while when the control signal **2** is Hi, the FET **302** is controlled to be OFF (out of conduction)

(see Table 1). Specifically, when the control signal 2 is Lo, the transistor 308 is turned off, so that Hi is input to the base of the transistor 307. As a result, the transistor 307 is turned on so that Lo is input to the gate of the FET 302. Consequently, the FET 302 is turned on. On the other hand, when the control signal 2 is Hi, the transistor 308 is turned on, so that Lo is input to the base of the transistor 307. As a result, the transistor 307 is turned off so that Hi is input to the gate of the FET 302. Consequently, the FET 302 is turned off.

The FET 303 is controlled to be ON (in conduction) when both the control signal 3 and the control signal 2 output from the camera controller 153 of the camera body 102 are Hi. When at least one of the control signal 3 and the control signal 2 is Lo, the FET 303 is controlled to be in one direction conducting state (diode state) which is enabled by the parasitic diode. Specifically, when both of the control signal 3 and the control signal 2 are Hi, the output from the AND circuit 313 becomes Hi and the Hi is input to the transistor 309. As a result, the transistor 309 is turned on and Lo is input to the gate of the FET 303. Consequently, the FET 303 is turned on. On the other hand, when at least one of the control signal 3 and the control signal 2 is Lo, the output from the AND circuit 313 becomes Lo and the Lo is input to the transistor 309. As a result, the transistor 309 is turned off and Hi is input to the gate of the FET 303. Consequently, the FET 303 is turned off to be out of conduction.

The FET 304 is controlled to be ON (in conduction) when both of the control signal 4 and the control signal 1 output from the camera controller 153 of the camera body 102 are Hi. When at least one of the control signal 4 and the control signal 1 is Lo, the FET 304 is controlled to be OFF (out of conduction). When the FET 304 is turned off, it becomes in the one direction conducting state (diode state) by the parasitic diode. Specifically, when both of the control signal 4 and the control signal 1 are Hi, the output from the AND circuit 314 becomes Hi and the Hi is input to the transistor 310. As a result, the transistor 310 is turned on so that Lo is input to the gate of the FET 304. Consequently, the FET 304 is turned on to be in conduction. On the other hand, when at least one of the control signal 4 and the control signal 1 is Lo, the output from the AND circuit 314 becomes Lo and the Lo is input to the transistor 310. As a result, the transistor 310 is turned off and Hi is input to the gate of the FET 304. Consequently, the FET 304 is turned off to be out of conduction.

It is assumed that any of the control signal 1, the control signal 2, the control signal 3, and the control signal 4 output from the camera controller 153 of the camera body 102 outputs Lo when the power switch 152 of the digital camera 100 is off. Therefore, when the battery 201 and the battery 202 are mounted to the digital camera 100 and the power switch 152 is off, the FETs 301 and 302 are on (in conduction) and the FET 303 and the FET 304 are in the one direction conducting state. In that case, power from the battery 201 and the battery 202 is supplied to the DC-DC converter 154. However, when the power switch 152 is off, power is not supplied from the DC-DC converter 154 to the respective components. Because of the one direction conducting state of the FET 303 and the FET 304, the battery 201 and the battery 202 never short-circuit.

2. Operation of Power Source Switching Circuit

The operation of the entire power source switching circuit 300 of the digital camera 100 will be described below with reference to FIG. 2.

2-1. Operation in the Normal State

As the operation in the normal state of the digital camera 100, the operation performed upon power-on will be described first.

When the power switch 152 of the digital camera 100 is turned on by the user, power supply from the battery 201 and the battery 202 cause the camera controller 153 to start activation and the digital camera 100 starts up. After the camera controller 153 starts up, the camera controller 153 checks the remaining voltage of the battery 201 with a voltage monitor 1 terminal. Similarly, the camera controller 153 checks the remaining voltage of the battery 202 with a voltage monitor 2 terminal. The camera controller 153 compares the remaining voltage of the battery 201 with the remaining voltage of the battery 202 and performs a power control so that the battery with the higher remaining voltage is used first.

When the remaining voltage of the battery 201 is higher than the remaining voltage of the battery 202, the camera controller 153 performs the power control so that power is supplied from the battery 201 and power is not supplied from the battery 202. Specifically, as illustrated in FIG. 3, the camera controller 153 controls the control signal 2 to be Hi. Then, after a predetermined waiting time (Th) passes, which is enough for the FET 302 to transit from the conduction state (on state) to the out-of conduction state (off state), the camera controller 153 controls the control signal 3 to be Hi. On that occasion, the control signal 1 and the control signal 4 remain Lo. Therefore, the FET 301 and the FET 303 are in the conduction state (on state), the FET 302 is in the out-of conduction state (off state), and the FET 304 is in the one direction conducting state.

On the other hand, when the remaining voltage of the battery 202 is higher than the remaining voltage of the battery 201, the camera controller 153 performs the power control so that power is supplied from the battery 202 and power is not supplied from the battery 201. Specifically, as illustrated in FIG. 4, the camera controller 153 controls the control signal 1 to be Hi. Then, after the predetermined waiting time (Th) passes, which is enough for the FET 301 to transit from conduction state to out-of conduction state, the camera controller 153 controls the control signal 4 to be Hi. On that occasion, the control signal 2 and the control signal 3 remain Lo. Therefore, the FET 302 and the FET 304 are in the conduction state, the FET 301 is in the out-of conduction state, and the FET 303 is in the one direction conducting state.

Once the digital camera 100 starts up, the user is allowed to freely set switching between the battery 201 and the battery 202 to be used by using a menu screen or the like of the digital camera 100. For example, when the remaining voltage of the battery 201 is higher than the remaining voltage of the battery 202 at the moment of starting up the digital camera 100, it is decided to use the battery 201 according to the above described control. Thereafter, in the case where the user makes setting of the battery to use, the power source switching circuit 300 selects appropriately either one of the battery 201 and the battery 202 to use, according to the setting.

For example, in the case where the battery 201 is set as a battery to use at the start-up of the digital camera 100 and, thereafter, the user sets the battery 202 as a battery to use, the camera controller 153 performs switching to the battery 202. Specifically, as illustrated in FIG. 5, the camera controller 153 controls the control signal 3 to be Lo. After the predetermined waiting time (Th), the camera controller 153 controls the control signal 2 to be Lo. At that time, the FETs 301 and 302 are in the conduction state (on state) and the FET 303 and the FET 304 are in the one direction conducting state. As a result, power is supplied from both of the battery 201 and the battery 202. Therefore, the power of the digital camera 100 is never turned off during the switching process of the batteries. Since the FET 303 and the FET 304 are in the one direction conducting state, the battery 201 and the battery 202 are never

11

short-circuited. Thereafter, the camera controller 153 controls the control signal 1 to be Hi. After the predetermined waiting time (Th), the camera controller 153 controls the control signal 4 to be Hi. At that time, the FET 301 is in the out-of conduction state (off state) and the FET 303 is in the one direction conducting state. The FET 302 and the FET 304 are in the conduction state (on state). As a result, power is supplied from the battery 202 and the power supply from the battery 201 stops. In that manner, the battery 201 is switched to the battery 202. Further, in the process of switching the battery 201 to the battery 202, a time period (Tp) (time t11 to t12) in which both of the battery 201 and the battery 202 supply power is provided. Therefore, the digital camera 100 is never turned off during the switching process of the batteries. Since the FET 303 and the FET 304 are in the one direction conducting state during the time period Tp, a short-circuit never occurs between the battery 201 and the battery 202.

In the case where the user sets the battery 201 as the battery to use while the battery 202 is currently set as the battery to use, the camera controller 153 controls the control signal 4 to be Lo, and after the predetermined waiting time (Th), the camera controller 153 controls the control signal 1 to be Lo, as illustrated in FIG. 6. At that time, the FETs 301 and 302 are in the conduction state (on state) and the FET 303 and the FET 304 are in the one direction conduction state, so that power is supplied from both of the battery 201 and the battery 202. Thereafter, the camera controller 153 controls the control signal 2 to be Hi, and after the predetermined waiting time (Th), the camera controller 153 controls the control signal 3 to be Hi. At that time, the FET 302 is in the out-of conduction state (off state) and the FET 304 is in the one direction conducting state. The FET 301 and the FET 303 are in the conduction state. As a result, power is supplied from the battery 201 and the power supply from the battery 202 stops. In that manner, the battery 202 is switched to the battery 201. Further, in the process of switching the battery 202 to the battery 201, the time period (Tp) (time t11 to t12) in which both of the battery 201 and the battery 202 supply power is provided. Therefore, the power of the digital camera 100 is never turned off during the switching process of the batteries. Since the FET 303 and the FET 304 are in the one direction conducting state during the time period Tp, the battery 201 and the battery 202 are never short-circuited.

2-2. Operation in an Abnormal State

As the operation in an abnormal state of the digital camera 100, the operation in the case where the camera controller 153 runs away out of control and, accordingly, cannot output the normal control signal will be described.

Problems of a conventional power source switching circuit will be described first. In a situation of using a typical power source switching circuit, there may be a problem of short-circuit of the battery 201 and the battery 202. For example, it is assumed that a power source switching circuit which has the same circuit configuration as that illustrated in FIG. 2 except for the AND circuit 313 and the AND circuit 314 and which has the FET 303 which is turned on (in conduction) when the control signal 3 is Hi and the FET 304 which is turned on (in conduction) when the control signal 4 is Hi. In a power source switching circuit having such a configuration, when the camera controller 153 runs away out of control and, accordingly, cannot output the normal control signal the state may occur, where the battery 201 and the battery 202 short-circuit. That will be described in detail below.

For example, when the camera controller 153 runs away out of control and causes the control signal 1, the control signal 2, and the control signal 3 to be Lo and causes the control signal 4 to be Hi, the FET 301, the FET 302, and the

12

FET 304 are in the conduction state, and the FET 303 is in the one direction conducting state. As a result, the battery 201 and the battery 202 are short-circuited and a charging path is formed from the battery 201 to the battery 202.

When the camera controller 153 causes the control signal 1, the control signal 2, and the control signal 4 to be Lo and causes the control signal 3 to be Hi, the FET 301, the FET 302, and the FET 303 are in the conduction state and the FET 304 is in the one direction conducting state. As a result, the battery 201 and the battery 202 are short-circuited and a charging path is formed from the battery 202 to the battery 201.

When the camera controller 153 causes the control signal 1 and the control signal 2 to be Lo and causes the control signal 3 and the control signal 4 to be Hi, the FET 301, the FET 302, the FET 303 and the FET 304 are brought into conduction (turned on) so that the battery 201 and the battery 202 are short-circuited. As a result, a charging path is formed from the battery 201 to the battery 202 or from the battery 202 to the battery 201.

On the other hand, in the power source switching circuit 300 of the present embodiment, the AND circuit 313 and the AND circuit 314 prevent the above described state. The FET 303 is controlled to be in conduction (turned on) when the control signal 3 is Hi and the control signal 2 is Hi output from the camera controller 153. The FET 303 is controlled to be in the one direction conducting state when at least one of the control signal 3 and the control signal 2 is Lo. The control signal 2 is a control signal for the FET 302, and the control signal 2 of Hi causes the FET 302 to be out of conduction (turned off). Therefore, the power source switching circuit 300 of the present embodiment is configured to not turn on the FET 303 (not bring the FET 303 in conduction) until the FET 302 is turned off (brought out of conduction) by the AND circuit 313, so that a charging path is not formed from the battery 202 to the battery 201. Similarly, the FET 304 is controlled to be turned on (in conduction) when the control signal 4 and the control signal 1 output from the camera controller 153 are Hi. The FET 304 is controlled to be in the one direction conducting state when at least one of the control signal 4 and the control signal 1 is Lo. The control signal 1 is a control signal for the FET 301, and the control signal 1 of Hi causes the FET 301 to be turned off (out of conduction). That is, the power source switching circuit 300 of the present embodiment is configured to not allow the FET 304 to be turned on (in conduction) until the FET 301 is turned off by the AND circuit 314, so that a charging path from the battery 201 to the battery 202 is not formed.

As such, according to the present embodiment, even in the case where the normal control signal cannot be output due to a runaway or the like of the camera controller 153 when either of the battery 201 and the battery 202 is used, the power source switching circuit 300 can prevent short-circuit from occurring between the battery 201 and the battery 202, thereby improving safety of the digital camera 100.

3. Summary

The digital camera 100 of the present embodiment has the power source switching circuit 300. The power source switching circuit 300 is a power source switching device which switches between the battery 201 and the battery 202 for the power source for supplying a driving voltage to the respective components (load section) of the digital camera 100. The power source switching circuit 300 has the FET 301 (the first switch circuit) which is provided between the battery 201 and the load section; the FET 302 (the second switch circuit) which is provided between the battery 202 and the load section; the FET 303 (the third switch circuit) which is provided between the battery 201 and the load section in

13

series with the FET **301**; the FET **304** (the fourth switch circuit) which is provided between the battery **202** and the load section in series with the FET **302**; the diode (the parasitic diode of the FET **303**) which is provided in parallel with the FET **303** for allowing a current to flow from the battery **201** to the load section while preventing a current from flowing into the battery **201**; the diode (the parasitic diode of the FET **304**) which is provided in parallel with the FET **304** for allowing a current to flow from the battery **202** to the load section while preventing a current from flowing into the battery **202**; and the AND circuits **313** and **314** which control the FETs **303** and **304** (the third switch circuit and the fourth switch circuit) to prevent a situation from occurring where at least one of the FET **303** (the third switch circuit) and the FET **304** (the fourth switch circuit) is turned on while both of the FET **301** (the first switch circuit) and the FET **302** (the second switch circuit) are in an on state.

With the above described configuration, even when the normal control signal cannot be output due to a runaway or the like of the camera controller **153**, the power source switching circuit **300** can prevent short-circuit from occurring between the battery **201** and the battery **202**, improving safety of the digital camera **100**.

Other Embodiments

As described above, the first embodiment has been discussed as an example of the technology disclosed in the present application. However, the technology in the present disclosure is not limited to that embodiment and may also be applied to embodiments which undergone modification, substitution, addition, omission or the like as required. Also, the respective constituent elements described in the first embodiment may be combined to form a new embodiment. Then, other embodiments will be exemplified below. The additional embodiments described below are non-exhaustive and other embodiments and variations are possible.

In the above described embodiment, the power source switching circuit **300a** is provided in the camera body **102** and the power source switching circuit **300b** is provided in the battery grip **103**. They are configured to form the power source switching circuit **300** when the battery grip **103** is mounted to the camera body **102**. However, the power source switching circuit **300** may be configured in either one of the camera body **102** and the battery grip **103** instead of being divided. Further, the battery **201**, the battery **202**, and the power source circuit **300** may be contained in either of the camera body **102** and the battery grip **103** (i.e., in a single electronic appliance).

Although the parasitic diodes of the FETs **303**, **304** are used as a diode for blocking a current flowing in a backward direction in the above described embodiment, the parasitic diodes may not be used. For example, diode devices separate from the FETs **303** and **304** may be connected in parallel with the FETs **303** and **304**, respectively.

Although the switch circuit and the diode connected in parallel with the switch circuit are configured by the FET **303** and the FET **304** in the above described embodiment, the switch circuit and the diode connected thereto may be configured by a relay and a diode connected in parallel with the relay.

Although the example using the AND circuit as illustrated in FIG. **2** is given as an example of the logic circuit in the above described embodiment, specific circuitry of the logic circuit is not limited to the configuration illustrated in FIG. **2**. That is, the logic circuit may be any circuitry as far as it

14

prevents a situation where at least one of the FET **303** and the FET **304** is turned on while both of the FET **301** and the FET **302** are on.

Although the predetermined waiting time (T_h) is set as the same value in the examples of FIG. **4** to FIG. **6** in the above described embodiment, the predetermined waiting time (T_h) is not limited to that. The respective predetermined waiting time may be decided as required.

The idea of the present disclosure is applicable not only to digital cameras but also to various electronic appliances which can connect a plurality of batteries such as, for example, movie cameras, portable phones with camera function, and personal computers.

The embodiment has been described above as examples of the technology of the present disclosure. For the purposes of describing the embodiment, the accompanying drawings and the detailed description have been provided.

Therefore, the constituent elements shown or described in the accompanying drawings and the detailed description may include not only the constituent element necessary to solve the problem but also the constituent element unnecessary to solve the problem in order to exemplify the technology. Accordingly, it should not be instantly understood that these unnecessary constituent elements are necessary since these unnecessary constituent elements are shown or described in the accompanying drawings and the detailed description.

Since the above described embodiments are for exemplifying the technology in the present disclosure, the embodiments may be subject to various kinds of modification, substitution, addition, omission, or the like without departing from the scope of the claims and their equivalents.

INDUSTRIAL APPLICABILITY

The present disclosure is applicable to electronic appliances which can connect a plurality of batteries such as digital cameras, movie cameras, and portable phones with a camera function.

What is claimed is:

1. A power source switching device which switches between a first power source and a second power source as a power source for supplying a driving voltage to a load section, the power source switching device comprising:

- a first switch circuit provided between the first power source and the load section;
- a second switch circuit provided between the second power source and the load section;
- a third switch circuit provided between the first power source and the load section in series with the first switch circuit;
- a fourth switch circuit provided between the second power source and the load section in series with the second switch circuit;
- a first diode provided in parallel with the third switch circuit, the first diode operable to allow a current to flow from the first power source to the load section while preventing a current to flow from the second power source to the first power source;
- a second diode provided in parallel with the fourth switch circuit, the second diode operable to allow a current to flow from the second power source to the load section while preventing a current to flow from the first power source to the second power source;
- a logic circuit operable to control the third switch circuit and the fourth switch circuit to prevent at least one of the third switch circuit and the fourth switch circuit from

15

turning on while both of the first switch circuit and the second switch circuit are in an on state; and
a control circuit operable to control the first switch circuit, the second switch circuit, and the logic circuit.

2. The power source switching device according to claim 1, 5
wherein when the control circuit outputs a signal for turning on both of the first switch circuit and the second switch circuit, the logic circuit outputs a signal for turning off both of the third switch circuit and the fourth switch circuit.

3. The power source switching device according to claim 1, 10
wherein when changing the first switch circuit from the off state to the on state, the logic circuit turns off the fourth switch circuit before turning on the first switch circuit, and when changing the second switch circuit from the off state to the on state, the logic circuit turns off the third switch circuit before 15
turning on the second switch circuit.

4. The power source switching device according to claim 1, 20
wherein the third switch circuit includes a first FET, the first diode includes a parasitic diode of the first FET, the fourth switch circuit includes a second FET, and the second diode includes a parasitic diode of the second FET.

5. An electronic appliance comprising the power source switching device according to claim 1.

6. A camera body which can be mounted with an interchangeable lens and includes a load section which is supplied 25
power from at least one of a first power source and a second power source, the camera body comprising:

a first switch circuit provided between the first power source and the load section;

a second switch circuit provided between the second power source and the load section; 30

a third switch circuit provided between the first power source and the load section in series with the first switch circuit;

a fourth switch circuit provided between the second power source and the load section in series with the second switch circuit; 35

a first diode provided in parallel with the third switch circuit, the first diode operable to allow a current to flow

16

from the first power source to the load section while preventing a current to flow from the second power source to the first power source;

a second diode that is provided in parallel with the fourth switch circuit, the second diode operable to allow a current to flow from the second power source to the load section while preventing a current to flow from the first power source to the second power source;

a logic circuit operable to control the third switch circuit and the fourth switch circuit to prevent at least one of the third switch circuit and the fourth switch circuit from turning on while both of the first switch circuit and the second switch circuit are in an on state; and

a control circuit operable to control the first switch circuit, the second switch circuit, and the logic circuit.

7. The camera body according to claim 6, wherein when the control circuit outputs a signal for turning on both of the first switch circuit and the second switch circuit, the logic circuit outputs a signal for turning off both of the third switch circuit and the fourth switch circuit.

8. The camera body according to claim 6, wherein the first power source is stored in the camera body and the second power source is provided outside the camera body.

9. The power source switching device according to claim 2, wherein when changing the first switch circuit from the off state to the on state, the logic circuit turns off the fourth switch circuit before turning on the first switch circuit, and when changing the second switch circuit from the off state to the on state, the logic circuit turns off the third switch circuit before turning on the second switch circuit.

10. The camera body according to claim 8, wherein the second power source is provided in a battery grip which can be mounted to the camera body.

11. The camera body according to claim 8, wherein the second power source supplies power to the load section via a power cord connected to the camera body.

* * * * *